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(54) HOLLOW YARN MEMBRANE MODULE AND ASSEMBLY FITTED WITH AIR DIFFUSING PIPE

(57) Abstract:

PURPOSE: To provide a hollow yarn membrane module easily and efficiently performing the restoration treatment of lowered filtering function even when the module is used in the filtering of highly polluted water.

CONSTITUTION: In a hollow yarn membrane module wherein the single end parts or both end parts of hol-

low yarn membranes are fixed in an opened state by the fixing member in one housing 2 or the fixing members in two different housing 2, an air diffusion pipe 4 is integrally fixed to the module.

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CLAIMS

Claim 1

The hollow fiber module which is a hollow fiber module which it comes to fix, the one end section or the both ends of a hollow fiber maintaining an opening condition by the hold-down member in one or two different housing, respectively, and is characterized by being fixed to a module and the powder trachea unifying.

Claim 2

The hollow fiber module according to claim 1 to which it consists of sheet-like hollow fiber knit fabrics, and it is fixed, the one end section or the both ends of a hollow fiber maintaining an opening condition by the hold-down member in one or two different housing, and the configuration of a cross section perpendicular to the hollow fiber of a hold-down member is characterized by having a powder trachea in the direction **** of a hollow fiber, and parallel by the hollow fiber module whose all are rectangles mostly.

Claim 3

It is fixed consisting of sheet-like hollow fiber knit fabrics, and the one end section or the both ends of a hollow fiber maintaining an opening condition by the hold-down member in one or two different housing. By the hollow fiber module whose all are rectangles mostly, the configuration of a cross section perpendicular to the hollow fiber of a hold-down member It has two powder tracheas fixed at catchment tubing or the hollow filament focusing edge, respectively. The hollow fiber module according to claim 2 characterized by the die length of each powder trachea being about 1 of effective hollow filament length/2, and having closed the point of a powder trachea, and for a powder trachea attaching an inclination in the modular direction of an outside, and allotting it to it toward a point from the fixed part of a powder trachea.

Claim 4

The hollow fiber module assembly characterized by arranging the powder trachea in the direction of **** of a hollow fiber, and parallel in the hollow fiber module assembly which it comes to connect with the conduit tube to which the structure material of a hollow fiber module leads filtrate so that it may come to arrange two or more hollow fiber modules of the flat tip which consists of sheet-like hollow fiber knit fabrics and each sheet-like hollow fiber may be located almost respectively in parallel.

Claim 5

The hollow fiber module assembly characterized by arranging the powder trachea perpendicularly to the direction of **** of a hollow fiber in the hollow fiber module assembly which it comes to connect with the conduit tube to which the structure material of a hollow fiber module leads filtrate so that it may come to arrange two or more hollow fiber modules of the flat tip which consists of sheet-like hollow fiber knit fabrics and each sheet-like hollow fiber may be located almost respectively in parallel.

DETAILED DESCRIPTION

1 Industrial Application. This invention relates to the hollow fiber module suitable for filtering the high liquid of especially corruption nature about a hollow fiber module.

2 Description of the Prior Art. Conventionally, although many hollow fiber modules are used in the so-called field of precision filtration, such as manufacture of non-

bacterial water, potable water, and a high purity water, and purification of air, they are performed in recent years in the form with various examination used for high-polluted-water processing applications, such as secondary treatment in a sewage disposal plant, tertiary treatment, and solid liquid separation in a septic tank.

3 Since the blinding of the hollow fiber at the time of filtration processing is large, after fixed time amount filtration processing, the hollow fiber module used for such an application sends air, vibrates a hollow fiber, a film front face is washed, or repeats film surface washing of letting treated water flow to filtration processing and hard flow, and is performing it. Film surface washing by sending air had many methods of performing modular film surface washing by attaching a powder trachea or a diffusion plate in the can equipped with a module, or a tub, and performing bubbling underwater there.

4 Problem to be solved by the invention. When filtration processing of high polluted water (for example, $ss >= 50\text{ppm}$, $TOC >= 100\text{ppm}$) was performed using such a conventional hollow fiber module, by hollow fibers' fixing (adhesion) and unifying them through deposits, such as the organic substance which adhered to the hollow fiber front face with use, the effective film surface product of the hollow fiber in a module decreased, and the rapid fall of a filtration flow rate was seen. Moreover, it did in this way, and functional recovery of the module which once carried out the fixing unification of the hollow fiber module which hollow fibers fixed and unified also when periodical film surface washing and a periodical back wash were performed was not easy, and decline in washing effectiveness was seen.

5 It is the hollow fiber module which it comes to fix , change to the hollow fiber module of a cylindrical shape with a focusing mold , arrange a hollow fiber in the shape of a sheet as a solution of this problem , and the one end section or the both ends of a hollow fiber maintain an opening condition by the hold-down member in one or two different housing , respectively , and the long and slender hollow fiber module which is a rectangle mostly is propose for each configuration of a cross section perpendicular to the hollow fiber of a hold-down member (JP 5-220356).

6 Since it becomes possible to prepare an interlayer spacing and to arrange a hollow fiber of such a hollow fiber module of a sheet-like flat tip equally in an inside-and-outside layer, and it becomes very easy to wash a hollow fiber front face equally in case it is film surface washing, it is a module suitable for filtration of high polluted water that decline in a filtration efficiency like the former can be suppressed etc.

7 Scrubbing washing mainly according [film surface washing of such a module] to Air is used. At this time, also in the hollow fiber module of the above flat tips, and the module of an old cylindrical shape, the powder trachea or the diffusion plate was installed in the can or the film immersion tub, and the method which equips with a module in a can or a tub, and is supported so that that Air bubbling may hit the whole module equally has been adopted.

8 When in the case of **** and this method a module is supported and it fixes, it is the complicated activity which is arranged so that the Air bubble may hit the whole module equally. Especially when equipping with two or more flat tip hollow fiber modules, it is necessary to apply Air equally to all modules, and becomes a still more

difficult activity. Moreover, first, even if it arranges a module appropriately, a module or a powder trachea moves slightly during operation, or there is a trouble that scrubbing washing effectiveness differs in each module and each part of a module for the reason of the flow rate of Air changing with locations of a powder trachea.

9 Furthermore, in the flat tip hollow fiber module using the sheet-like hollow fiber knit fabric of two or more sheets Perpendicularly [sheet surface] within tub, when the longitudinal direction of a hollow filament is leveled, a module is fixed and it operates It is important to pass the Air bubble between the knitting fabric of a hollow fiber, and to prevent fixing of the hollow filaments between knitting fabric and deposition of a suspended matter. There is also a problem that it is very difficult to arrange the powder trachea and module in a tub, respectively so that the Air bubble may be passed to between the knitting fabric of all modules. Even if it uses this invention for filtration of high polluted water, it aims to let the recovery of the filtration function which fell by use offer the hollow fiber module which can be carried out easily and efficiently.

10 Means for Solving the Problem. The summary of this invention is as follows.

(1) The hollow fiber module which is a hollow fiber module which it comes to fix, the one end section or the both ends of a hollow fiber maintaining an opening condition by the hold-down member in one or two different housing, respectively, and is characterized by being fixed to a module and the powder trachea unifying.

11 (2) a sheet -- ** -- a hollow fiber -- a knit fabric -- constituting -- having -- a hollow fiber -- one end -- the section -- or -- both ends -- one -- a ** -- or -- differing -- two -- a ** -- housing -- inside -- a hold-down member -- opening -- a condition -- maintaining -- while -- fixing -- having -- a hold-down member -- a hollow fiber -- being perpendicular -- a cross section -- a configuration -- any -- almost -- a rectangle -- it is -- a hollow fiber -- a module -- a hollow fiber -- **** -- a direction -- parallel -- powder -- a trachea -- having -- things -- the description -- ** -- carrying out -- (one --) -- a publication -- a hollow fiber -- a module.

12 (3) It is fixed, consisting of sheet-like hollow fiber knit fabrics, and the one end section or the both ends of a hollow fiber maintaining an opening condition by the hold-down member in one or two different housing. By the hollow fiber module whose all are rectangles mostly, the configuration of a cross section perpendicular to the hollow fiber of a hold-down member It has two powder tracheas fixed at catchment tubing or the hollow filament focusing edge, respectively. each -- powder -- a trachea -- die length -- effective -- a hollow filament -- merit -- about -- one -- /-- two -- it is -- powder -- a trachea -- a point -- closing -- **** -- and -- powder -- a trachea -- a fixed part -- from -- a point -- going -- a module -- an outside -- a direction -- powder -- a trachea -- an inclination -- attaching -- allotting -- having -- **** -- things -- the description -- ** -- carrying out -- (two --) -- a publication -- a hollow fiber -- a module.

13 (4) The hollow fiber module assembly characterized by arranging the powder trachea in the direction of **** of a hollow fiber, and parallel in the hollow fiber module assembly which it comes to connect with the conduit tube to which the structure material of a hollow fiber module leads filtrate so that it may come to arrange two or more hollow fiber modules of the flat tip which consists of sheet-like

hollow fiber knit fabrics and each sheet-like hollow fiber may be located almost respectively in parallel.

14 (5) The hollow fiber module assembly characterized by arranging the powder trachea perpendicularly to the direction of **** of a hollow fiber in the hollow fiber module assembly which it comes to connect with the conduit tube to which the structure material of a hollow fiber module leads filtrate so that it may come to arrange two or more hollow fiber modules of the flat tip which consists of sheet-like hollow fiber knit fabrics and each sheet-like hollow fiber may be located almost respectively in parallel.

15 This invention is explained at a detail according to a drawing below. Drawing 1 and drawing 2 are the external views having shown an example of the hollow fiber module of this invention, and drawing 1 is the module of a cylindrical shape and is the side elevation of the module which has arranged the powder trachea almost in parallel with the longitudinal direction of a hollow fiber. Drawing 2 is the perspective view of the module with which the ring-like powder trachea is fixed to the periphery of housing of one hollow fiber focusing edge of the module of a cylindrical shape.

16 Drawing 3 is the hollow fiber module of the flat tip which used the sheet-like hollow fiber knit fabric, and is the perspective view of the module which attached the powder trachea just under the hollow fiber knit fabric which made the sheet surface perpendicular and fixed the longitudinal direction of a hollow filament horizontally, and was arranged in the longitudinal direction of a hollow fiber, and parallel.

17 Drawing 4 is the hollow fiber module of a flat tip, and although the same hollow fiber as drawing 3 is fixed and the powder trachea is prepared just under the hollow fiber knit fabric, it is the module with which each powder trachea is fixed with catchment tubing using the powder trachea which closed the point, and the point of a powder trachea has two powder tracheae to which the inclination is given ****.

18 Drawing 5 is the perspective view of the hollow fiber module assembly which arranged the powder trachea in the lower part of a sheet-like hollow fiber module assembly perpendicularly to the direction of **** of a hollow filament. the installation fixture with which in 1 powder trachea, 5, and 5' fixes a conduit tube as for housing and 3, and, as for 4, a hollow fiber and 2 fix a powder trachea, and 6 -- in a manifold and 9, a powder trachea fixed part and 10 show filtrate output port, and 11 shows [a sheet-like hollow fiber and 7] catchment tubing, 8, 8', and 8" of Air input, respectively.

19 What consists of various ingredients, such as for example, a cellulose system, a polyolefin system, a polyvinyl alcohol system, and a polysulfone system, can be used for hollow fibers 1 and 6, and its thing of the high quality of the materials of strong ductility, such as polyethylene and polypropylene, is especially desirable. In addition, although there will be especially no limit in an aperture, a void content, thickness, and an outer diameter if usable as a filtration membrane, considering a removal object, reservation of the film surface product per volume, the reinforcement of a hollow fiber, etc., as a desirable example, 0.01-1 micrometer of apertures, 20 - 90% of void contents, 5-300 micrometers of thickness, and the range of 20-2000-micrometer outer diameter can be mentioned. Moreover, the aperture in the case of aiming at removal

of bacteria may use hundreds of thousands of ultrafiltration membrane from 10,000 cuts off molecular weight, when it becomes indispensable that it is 0.2 micrometers or less and it aims at removal of the organic substance or a virus.

20 It is desirable that it is the so-called lasting hydrophilization film which has a hydrophilic radical etc. in a front face as a surface characteristic of a hollow fiber. Well-known approaches, such as a method of manufacturing a hollow fiber with a hydrophilic macromolecule like a polyvinyl alcohol system as a process of the lasting hydrophilization film or the approach of carrying out hydrophilization of the front face of a hydrophobic poly membrane, can be used. For example, as an example of the hydrophilic giant molecule at the time of giving a hydrophilic giant molecule to a film surface and carrying out hydrophilization of the hydrophobic hollow fiber, an ethylene-vinyl acetate system copolymer saponification object, a polyvinyl pyrrolidone, etc. can be mentioned.

21 As an example of the film surface hydrophilicity by another technique, there is a film surface polymerization method of a hydrophilic monomer, and diacetone acrylamide etc. can be mentioned as an example of this monomer. Moreover, as other technique, the approach of blending a hydrophilic giant molecule and carrying out spinning film production can be mentioned to a hydrophobic giant molecule (for example, polyolefin), and what was mentioned above as an example of the hydrophilic giant molecule to be used is mentioned.

22 A hydrophobic interaction works that a front face is a hydrophobic hollow fiber between the processed underwater organic substance and a hollow fiber front face, the organic substance adsorption to a film surface occurs, it leads to film surface lock out, and a filtration life becomes short. Moreover, generally the filtration-efficiency recovery by film surface washing is also difficult for the blinding of the adsorption origin. The hydrophobic interaction on the organic substance and the front face of a hollow fiber can be decreased to use the lasting hydrophilization film, and adsorption of the organic substance can be suppressed. Furthermore, by the lasting hydrophilization film, although desiccation and hydrophobicity arise and the fall of flux may be caused by the bubbling air in scrubbing washing in use by the hydrophobic film, even if it dries, the fall of flux is not caused.

23 Housing 2 is also the member which functions as a member which fixes the hollow fiber focusing edge which has carried out resin immobilization, and fixes and supports a powder trachea. Moreover, the filtrate obtained from a hollow filament focusing end face is collected, and it leads to the conduit tube 3. A conduit tube 3 is a pipe with which filtrate flows. In order to perform film surface washing of a hollow filament, the powder trachea 4 is for performing Air bubbling underwater, and what opened the hole in the pipe is used for it. 2-5 mm and a pitch have [the diameter of a pipe / the path of 8-30 mm and a hole] the range desirable [although there is especially no limit in the path of a hole, and a pitch] when modular magnitude and the effectiveness of bubbling are taken into consideration of 30-200 mm.

24 A polycarbonate, polysulfone, polypropylene, acrylic resin, ABS plastics, denaturation PPO resin, polyvinyl chloride resin, etc. are mentioned to housing 2, a conduit tube 3, and a list that what is necessary is just what has a mechanical strength and endurance as the quality of the material of the powder trachea 4. Moreover,

metals which are hard to corrode, such as stainless steel, can also be used. As long as the installation fixture 5 and 5' which fix a powder trachea can fix a powder trachea, what kind of object is sufficient as them, and if they are an object with which the quality of the materials, such as a product made from stainless steel and a product made of resin, are also hard to be corroded, they will not be cared about.

25 It is the object which knit the hollow fiber in the shape of a sheet, and if equipment and the approach which the technique of arbitration is used as a process of a sheet-like hollow fiber, for example, are indicated by JP 4-26886 and JP 63-91673 are used for the sheet-like hollow fiber 6, it is easy.

26 The catchment tubing 7 functions as a member which supports the whole hollow fiber module of a flat tip, and long and slender -- it has rectangular opening mostly. the configuration of the cross section where opening of this catchment tubing 7 is perpendicular to the hollow fiber of the hold-down member by which restoration immobilization is carried out with a hollow fiber there is long and slender -- a rectangle is carried out mostly. In addition, through the output port of filtrate, another one side is closed and opening of one side of catchments tubing is fixing the powder trachea by the powder trachea fixed part 9.

27 It is a hold-down member at the time of fixing a manifold 8, 8', and 8" of catchment tubing of the hollow fiber module of a flat tip, and carrying out the juxtaposition unification of two or more modules. The modular upper manifold 8 has the structure where tubing passes along the center of a manifold so that the filtrate obtained from each catchment tubing can be collected. By downward manifold 8' and the member which fixes no less than 8" of two or more modules, while catchment tubing is fixed, one end of catchment tubing is closed. Moreover, 8' also has the role which fixes a powder trachea, and while fixing a powder trachea, tubing which leads is running along 8" of Air. The catchment tubing 7, a manifold 8, 8', and the 8" quality of the material apply to the quality of the materials, such as the aforementioned powder trachea, correspondingly.

28 In drawing 3 and drawing 4 , the edge of the catchment tubing 7 bottom is closed and does not lead in the powder trachea 4. Moreover, the powder trachea 4 of drawing 4 may incline in the shape of a straight line, although the inclination is given in the drawing so that a curve may be drawn. When using two or more modules for the drawing 3 list in the module of drawing 4 , it is desirable to use it, making it stand in a row so that a sheet surface may lap.

29 Although the smaller one of spacing of the sheet which in the case of a hollow fiber module assembly like drawing 5 adjoins if it takes into consideration performing Air scrubbing in a list efficiently in order to use a can and a processing tub as a compact is desirable, if spacing is narrowed too much, it is possible to be hard coming to pass the Air bubble between sheets. Therefore, spacing with suitable spacing between sheets is required, and the range of 5-60 mm is suitable for the spacing. In consideration of back wash conditions, such as modular magnitude, sheet number of sheets, and Air scrubbing, spacing between sheets can be chosen in fact. Moreover, although the powder trachea 4 is perpendicularly arranged to the modular direction of **** in the drawing, even if it arranges this powder trachea in parallel with the direction of ****, it does not interfere.

30 Although the so-called pressure filtration approach of arranging a module in a well-closed container, pressurizing processed water in use of the hollow fiber module of this invention, and making a hollow fiber penetrating is also employable, it is desirable to use it by the suction filtration method which attracts the side which collects the treated water which arranged the hollow fiber module in the activated sludge tank, the settling tank, etc., and penetrated the hollow filament filtration membrane. By adopting the so-called intermittent suction operating method which stops predetermined time suction periodically especially, a film surface deposit can prevent entering to internal pore efficiently, and the functional recovery frequency of a hollow fiber module can be reduced.

31 Function. Since the powder trachea is united with the hollow fiber module, Air scrubbing is equally performed to the whole module, and washing effectiveness rises. The activity of arrangement and wearing becomes very easy and it becomes unnecessary to set up the fine physical relationship of a powder trachea and a module in the case of wearing to a can or a processing tub, because the powder trachea and the module are unifying. Moreover, even if a modular location may shift from an early location during operation, Air scrubbing is performed appropriately.

32 By the case where it is the powder trachea to which the inclination is *** given in the center section of the flat tip module, Air scrubbing will mainly be made by the whole module near [where transparency flux is the largest] the potting, and a high filtration flow rate can be maintained by stopping the blinding of this part for blinding for a long time. Since wearing is very easy and Air scrubbing at the time of operation is also efficiently performed to the whole module, what arranged the powder trachea in two or more flat tip modules is applicable to the processing tub which requires a large film surface product.

33 Example. An example explains this invention concretely. The hollow fiber module as shown in example 1 drawing 3 was produced. The hollow fiber 6 was a porosity hollow fiber made from polyethylene which held the saponification object of an ethylene-vinyl acetate copolymer on the front face, knit this in the shape of a sheet, and made it the knit fabric. The *** lay length carried out the laminating of two of them using that 790 mm and whose array lay length of a hollow fiber are 500 mm, and the hollow fiber knit fabric fixed the both ends of a hollow fiber knit fabric with polyurethane resin. In addition, resin immobilization of each edge of a hollow fiber 6 was carried out, with the opening condition maintained. Thus, the modularization of the hollow fiber knit fabric which carried out resin immobilization of the both ends was inserted in and carried out to the pipe made from a polyvinyl chloride.

34 The pipe used what has put in the cut according to the dimension of the resin fixed part of a hollow fiber beforehand using the thing with the bore of 30 mm, an outer diameter [of 35 mm], and a die length of 600 mm. This pipe hits the catchment tubing 7. The edge of the respectively same one side connects the conduit tube for collecting filtrate with two catchment tubing, and another edge is closed, respectively and is fixing the powder trachea in this part, respectively. A powder trachea is a pipe made from a polyvinyl chloride, and the pipe which opened the hole with a diameter of 3 mm in the thing with a bore [of 10 mm] and an outer diameter of 13 mm in 60 mm pitch was used for it.

35 This module was immersed in 200 ppm yeast suspension underwater, and the entry side of a pump was connected with the conduit tube, and from secondary [modular], it drew in with the pump and filtered. Delivery and Air scrubbing were continuously performed for Air of 35 NI/min to the powder trachea during filtration operation. Consequently, good scrubbing washing was performed, in the amount filtration of steady flow of $0.013\text{m}^3 / \text{m}^2$, and h, the differential pressure between six-month mesenteriolum is 10 - 25 cm Hg, and stable filtration was performed.

36 The hollow fiber module assembly as shown in example 2 [drawing 5](#) was produced. The hollow fiber knit fabric which carried out resin immobilization of the both ends like what was produced in the example 1 was produced, and the modularization of this was inserted in and carried out to the pipe made from a polyvinyl chloride. The pipe used what has put in the cut according to the dimension of the resin fixed part of a hollow fiber beforehand using the thing with the bore of 30 mm, an outer diameter [of 35 mm], and a die length of 600 mm. This pipe hits the catchment tubing 7. Such four hollow fiber modules were produced, in the condition of having made it standing in a row so that a sheet surface may lap, the edge of catchment tubing was fixed with the manifold, respectively, and the assembly of four modules was produced.

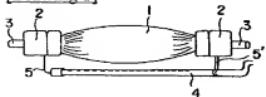
37 It has the structure where tubing passes along the center section in a manifold in a drawing so that a manifold 8 can collect the filtrate obtained from each catchment tubing, and opening of each catchment tubing enabled it to collect filtrate through the tubing. On the other hand, each module was fixed and downward manifold 8' and at least 8" of openings of catchment tubing were closed to it and coincidence. Moreover, the powder trachea was fixed by manifold 8' and 8", and scrubbing air was supplied to the powder trachea through tubing inside manifold 8". A powder trachea is a pipe made from a polyvinyl chloride, and the pipe which opened the hole with a diameter of 3 mm in the thing with a bore [of 10 mm] and an outer diameter of 13 mm in 30 mm pitch was used for it. The die length of a pipe is 180 mm and closed the tip. This pipe was arranged at equal intervals at right angles to 4 and the direction of *** of a hollow filament.

38 It was immersed in 200 ppm yeast suspension underwater, and filtered by attracting this module assembly with a pump from secondary [modular]. Delivery and Air scrubbing were continuously performed for Air of 70 NI/min to the powder trachea during filtration operation. Consequently, good scrubbing washing was made by the whole module, and in the amount filtration of steady flow of $0.013\text{m}^3 / \text{m}^2$, and h, the differential pressure between six-month mesenteriolum is 10 - 25 cm Hg, and has continued the stable filtration.

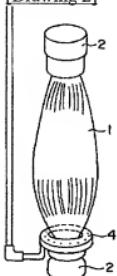
39 Effect of the Invention. Since the hollow fiber module of this invention has unified the powder trachea and the module, wearing to a can or a processing tub is easy, and arrangement of a module and a powder trachea is performed appropriately. Therefore, since equal Air scrubbing is made by the whole module and washing effectiveness rises, the blinding to a film surface is controlled and a high filtration flow rate carries out long duration continuation.

DRAWINGS

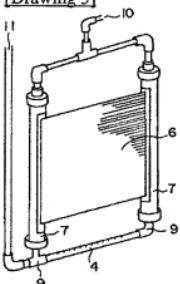
[Drawing 1]



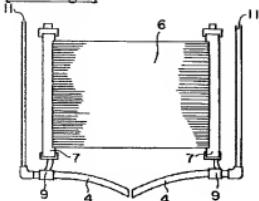
[Drawing 2]



[Drawing 3]



[Drawing 4]



[Drawing 5]

